

**APPENDIX**

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## FIRE SERVICE GOALS

This appendix provides a general discussion regarding the “targets” or “community goals” which have been adopted by jurisdictions throughout the United States and serve as a baseline for determining optimal service levels for purposes of comparison in this report.

- **THERE IS EXTENSIVE DEBATE REGARDING THE MOST APPROPRIATE APPROACH TO DEFINING SERVICE LEVELS IN THE FIRE SERVICE.**

This appendix provides a summary of the various fire service targets that have been developed for the evaluation of staffing and deployment. These represent a range of thinking including efforts to identify critical points in the combat of structure fires as well as the need to intervene in medical emergencies. While these neither cover every eventuality nor cover each community’s special needs, they serve as an important starting point for conducting such an analysis.

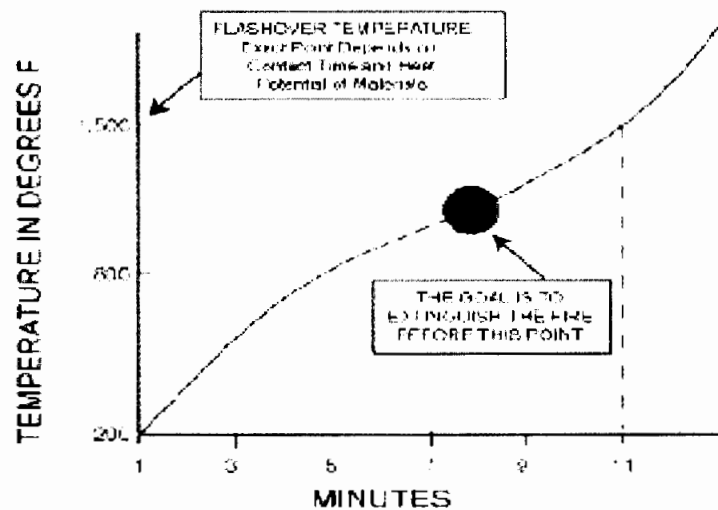
♦ **Most Targets for Fire and EMS Service Delivery Are Based on Research into Fire Behavior and Cardiac Survival.**

Most fire and emergency medical service targets or goals have their basis in research that has been conducted into two critical issues:

- a. What is the critical point in a fire’s “life” for gaining control of the blaze?
- b. What is the impact of the passage of time on survivability for victims of cardiac arrest?

The graphic, that follows, shows the typical “flashover” curve for interior structure fires. The point of “flashover” is critical because it defines when all of the contents of a room become involved in the fire. This is also the point at which a fire changes from “room and contents” to a structure fire – involving a wider area of the building. Note that this graphic depicts a fire from the moment of inception – not from the moment that a fire is detected or reported. This demonstrates the criticality of early detection and fast reporting and dispatch of responding units. This also shows the critical need for a rapid (and sufficiently staffed) initial response – by quickly initiating the attack on a fire, “flashover” can be averted.

### Generalized Flashover Curve



The points, below, describe the major changes that occur at a fire when "flashover" occurs:

- It is the end of time for effective search and rescue in a room involved in the fire. It means that likely death of any person trapped in the room – either civilian or firefighter.
- After this point in a fire is reached, portable extinguishers can no longer have a successful impact on controlling the blaze. Only hand-lines will have enough water supply to affect a fire after this point.
- The fire has reached the end of the "growth" phase and has entered the fully developed phase. During this phase, every combustible object is subject to the full impact of the fire.
- This also signals the changeover from "contents" to "structure" fire. This is also the beginning of collapse danger for the structure. Structural collapse begins to become a major risk at this point and reaches the highest point during the decay stage of the fire (after the fire has been extinguished).

It should be noted that not every fire will reach flashover – and that not every fire will "wait" for the 8-minute mark to reach flashover. A quickly responding fire crew can do things to prevent or delay the occurrence of flashover. These options include:

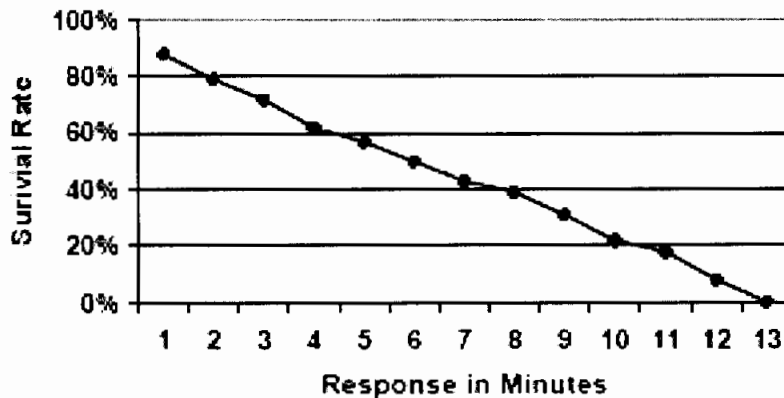
- Application of portable extinguisher or other "fast attack" methodology.

- Venting the room to allow hot gases to escape before they can cause the ignition of other materials in the room.
- Not venting a room – under certain circumstances this may limit a fire and prevent flashover from occurring.

Each of these techniques requires the rapid response of a company that can safely initiate these actions. Under most circumstances, this requires at least three firefighters on-scene. OSHA however, requires that except in exigent circumstances requiring action to safeguard life, a minimum of 2-people must be available as a rescue crew outside of a building before a crew can enter a burning building. OSHA, then, as a practical matter at fire scenes, results in working groups of four persons.

The second issue to consider is the delivery of cardiac and other emergency medical first response. The exhibit, below, demonstrates the survivability of cardiac patients as a timeline:

### % Survival Rate



This graph shows the results of extensive studies of the survivability of patients suffering from cardiac arrest. This is the most-often studied issue due to the ease of evaluating the outcome (a patient either survives or does not) from a cardiac arrest. This research results in guidelines for the provision of basic life support (BLS) within four minutes of notification and the provision of advanced life support (ALS) within 8 minutes of notification. The goal is to provide BLS within 8 minutes of the onset of the incident (including detection, dispatch and travel time) and ALS within 12 minutes. Further descriptions of practical research into these issues are summarized in the section that follows.

**(2) Extensive Research Has Been Conducted Regarding the Impact of Response Times, Company Staffing, and Other Factors on Service Delivery.**

The fire service lends itself to statistical study – there is a large sample of events to choose from and there are a large number of service providers who deliver service in various ways. This creates a “natural laboratory” for examining the impact of various policy decisions. Some of that research and its impacts on fire service staffing, deployment and service level targets or goals are provided in the table below:

**FIRE/EMS PLANNING FACTORS**

<b>Response Factor</b>	<b>Description of Factor</b>	<b>Research Results</b>
<b>Response Time to Fires</b>	<ul style="list-style-type: none"><li>• Elapsed time between receipt of a call at the dispatch center and arrival of units at the scene.</li><li>• Relationship between response time and the likelihood that units can control the spread of a fire.</li><li>• Response time controllable through station location, avail-ability of staff, training and characteristics of jurisdiction.</li></ul>	<ul style="list-style-type: none"><li>• "Flashover" (the point at which temperatures in a structure reach a point at which materials simultaneously ignite) normally occurs between 6.5-10 minutes from ignition. Structural damage progresses geometrically from ignition.</li><li>• Station networks in urbanized settings usually designed to deliver initial response to fires in 4 minutes to 80%-90% of calls.</li></ul>
<b>Response Time to Medical Calls</b>	<ul style="list-style-type: none"><li>• Elapsed time definition the same as for fires.</li><li>• Relationship between response time and the likelihood that units can increase the survivability potential in certain situations (e.g., cardiac arrests).</li><li>• Most medical response systems designed to be "two-tier" -- initial basic life support (BLS) response by fire personnel within 4-5 minutes utilizing techniques ranging from first aid and CPR to cardiac defibrillation; advanced life support (ALS) response by paramedics within 8-10 minutes utilizing a wide variety of techniques (e.g., drugs, telemetry to hospital, etc.).</li></ul>	<ul style="list-style-type: none"><li>• King County EMS (Seattle) has conducted extensive research on the survival rates associated with response times for ALS/BLS units. These studies show an average survival rate of 43% for cardiac arrest calls in which BLS response is within 4 minutes and ALS response is within 8 minutes. If each response time is doubled, (to 8 and 16 minutes, respectively) survivability falls to 6%. Use of defibrillation devices increases survivability rates for cardiac situations for all response systems.</li></ul>



<b>Company Size</b>	<ul style="list-style-type: none"> <li>• Number of personnel assigned to a unit -- especially for fire calls.</li> <li>• As with response time, engine company size is a significant factor in enabling personnel to control the spread of a fire.</li> <li>• Much debate in fire professional circles about optimum company size -- larger units can perform more tasks at a fire scene more quickly.</li> <li>• Actual amount of staff required at specific fires dependent on size of structure, combustibility, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Extensive research by the Dallas Fire Department has indicated that the relative effectiveness of 3, 4 and 5 person companies is least pronounced in the private, single-family residence fire and widens as the size of the structure involved increases.</li> <li>• Comparatively, fire departments serving large, metropolitan areas staff engine and truck companies with additional personnel in high hazard areas (e.g., high levels of water flow required, high-rise structures, industrial occupancies, etc.).</li> <li>• In "ordinary" hazardous areas (single-family residential, small commercial, etc.), 3 person engine companies normally encountered and viewed to be effective mix of performance versus costs.</li> </ul>
<b>Aerial Ladder Truck Availability</b>	<ul style="list-style-type: none"> <li>• Ability to maximize response capabilities on structure fires involves obtaining an aerial ladder truck within a specified time to perform roof ventilation, elevated water stream, and additional persons for rescues.</li> </ul>	<ul style="list-style-type: none"> <li>• Research conducted by the Dallas and Seattle Fire Departments indicate that an effective target for aerial ladder truck response is within an 8-10 minute timeframe.</li> </ul>
<b>Initial Response Capability</b>	<ul style="list-style-type: none"> <li>• The total number of people able to respond on-scene to a fire within a specified time is a critical element to controlling its spread.</li> </ul>	<ul style="list-style-type: none"> <li>• Again, Dallas Fire Department time trials indicate that in "ordinary" hazard areas that a minimum of three 3-person units required in an 8-10 minute timeframe.</li> </ul>
<b>Automatic Sprinkler Systems</b>	<ul style="list-style-type: none"> <li>• Use of automatic sprinkler systems in new construction has been shown in many communities (particularly in the sunbelt states where a greater proportion of construction is newer than in the northern and eastern United States) to reduce fire loss, loss of life, firefighter injuries, and time devoted to handling fire calls. Typically, costing 1%-2% of construction, automatic sprinkler systems also results in lower insurance premiums.</li> </ul>	<ul style="list-style-type: none"> <li>• For Scottsdale, the impact of requiring sprinklers in all new construction has been to allow them to extend emergency response times and/or build fewer fire stations.</li> <li>• Other agencies have mandated built-in fire protection on all new construction out-side of a specified response time capability of the fire department (e.g., five minutes) as a way to mitigate the impacts of fires on outlying areas.</li> <li>• While automatic sprinkler systems can influence fire service resource requirements, there is no effect on EMS needs.</li> </ul>

The number of persons staffing engine and truck companies is a significant factor affecting fire service requirements in terms of engine company staffing. While there has been much debate about the most appropriate engine company staffing level, it is clear from a landmark study completed by the City of Dallas and the /Dallas Fire Department that the effectiveness of alternative engine company staffing levels is least pronounced in lower density jurisdictions (i.e., those without very large downtown areas and higher risk occupancies). For this reason, communities that are primarily suburban and moderate downtown density commonly target a three-person engine company size. These differences are illustrated in the table shown on the following page:

**Illustrative Performance Levels  
Demonstrated in Dallas Fire Study**

Single-Family Home - Response Tasks						
Crew Size	Line	Window	Search	Line	Window	Completed
	Charged (In Mins.)	Ventilation (In Mins.)	Completed (In Mins.)	Charged (% Diff. Ea. Increm.)	Ventilation (% Diff. Ea. Increm.)	
5	2.9	3.7	5.1	(15%)	(16%)	(29%)
4	3.4	4.4	7.2	(15%)	(12%)	+11%
3	4.0	5.0	6.5	-	-	-
Two Story Apartment House						
	Line Charged Front of Bldg.	Line Charged Back of Bldg.	Line Charged Front of Bldg.	Line Charged Back of Bldg.		
5	1.5	1.4	(21%)	(13%)		
4	1.9	1.6	(42%)	+45%		
3	3.3	1.1	-	-		

The table above shows illustrative performance levels for single-family and multi-family residential structures. There is a clear decrease in response capabilities as the staffing levels on an engine company decline, although the performance of individual tasks varies. This distinction is greatest for the larger occupancy then it is for the single-family home. If the three single-family home tasks are averaged to create an "index" of performance, the five-person company is at 3.9, the four- person company is at 5.0, and the three-person company is at 5.2. This leads to the conclusion that, for smaller/lower risk occupancies, the risk/staffing trade-off is most pronounced for the five-person versus four-person companies and less pronounced for the four-person versus three-person companies.

**(3) The National Fire Protection Association Has Developed a Set of Guidelines for Fire Service Deployment and Response Capabilities.**

The National Fire Protection Association (NFPA) has endeavored to address the debate regarding the appropriate service levels by drafting a new set of

guidelines or 'standards' called NFPA 1720 – which is recommended for the delivery of fire and rescue services in mostly volunteer fire departments. The title of the standard is "Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Volunteer Fire Departments (2004 Edition)."

### **What NFPA 1720 Is?**

- A recommended set of guidelines or 'standards' of service for fire, EMS, and other fire department activities.
- A tool for local policy makers to use when evaluating their own service delivery networks.

### **What NFPA 1720 Is Not?**

- A law, a regulation, or a requirement for cities and other municipalities to follow.
- An immediate requirement – NFPA 1720 lays out a master planning process for each community to evaluate its own needs.  
*(1.4 Equivalency – Nothing in this standard is intended to prohibit the use of systems, methods, or approaches of equivalent or superior performance to those prescribed in this standard. Technical documentation shall be provided to the authority having jurisdiction (AHJ) to demonstrate equivalency.)*

### **What NFPA 1720 Recommends:**

- Dispatch handling times equal to one (1) minute or less.
- En route times (reaction times) equal to one (1) minute or less.
- Travel times for the initial arriving unit (or for the delivery of BLS level care in an EMS system) of four (4) minutes or less, 90% of the time.
- Travel times for a full structure fire response (defined below as 12 – 15 people) or for an ALS response (also defined below) in eight (8) minutes or less, 90% of the time.
- The standard for fire can also be met if four (4) firefighters are on-scene in four (4) minutes or less.
- An ALS response is defined in the standard as at least four people, at least two (2) of who should be paramedics and two (2) of who are at the EMT–basic level.

- An initial full structure fire response is defined as 12 –15 people for urban areas:
  - One (1) incident commander.
  - One (1) supply line.
  - Two (2) attack lines of two (2) people plus one (1) support person (for a total of six people).
  - One (1) search and rescue team of at least two (2) people.
  - One (1) ventilation team of at least two (2) people.
  - One rapid intervention team (RIC) comprised of at least two (2) people. This team can be formed from other staff on scene until a dedicated RIC arrives. This would reduce the staffing required on the first response to 12 people.
  - If in use, one (1) aerial operator should be assigned to maintain control of the aerial unit.

**NFPA 1720 - Table 4.3.2 Staffing and Response Times**

Demand Zone	Demographics	Staffing and Response Times	Percentage
Special	AHJ	AHJ	90
Urban	1000 people / sq. mi.	15 /9	90
Suburban	500 – 1000 people / sq. mi.	10 /10	80
Rural	< 500 people / sq. mi	6 /14	80
Remote*	≥Travel Distance 8 miles	4	90

*\*Upon assembling the necessary resources at the emergency scene, the fire department should have the capability to safely initiate attack within 2 minutes 90 percent of the time.*

Goal should be designed to achieve these response times and staffing levels at a minimum of 90% of applicable calls for service. Engine / aerial company staffing should be a minimum of four (4) people:

- However, NFPA 1720 explicitly recognizes that there are many ways to achieve this result.
- The standard does not require that four (4) people arrive on the scene in the same unit.

- Could use, for example, a department with many two-person units that provide this level of coverage (i.e., all calls receive two units minimum).